Homework Set #2

(Total Score: 20 points)

1. The Fermilab Tevatron accelerates protons to 1 TeV energy. If the accelerator ring, which is 6 Km in circumference, is filled with air, calculate the energy lost by the proton per turn. (Assume protons as MIPs.) Also, with $\beta \sim 1$, estimate how long it would take to lose the total beam energy by ionization. (2+1 points)
2. Using the plot for Range/Mass vs $\beta\gamma$, calculate the thickness of iron needed to stop 10 GeV muons. (2 points)
3. If the critical energy at which the radiative loss is equal to the ionization loss is ~ 8 MeV for electrons in Lead, calculate the critical energy for muons. (2 points)
4. Calculate the Cerenkov emission angle for a 3 GeV/c momentum pion, Kaon and proton. (2+1+1 points)
5. Calculate the drift velocity of electrons in Ar+38% isobutane at STP, in an electric field of 2 KV/cm, if the mobility of electrons is 2500 $cm^2/V\text{-}s$. Also, calculate the transverse size of the electron cloud after a drift of 1 cm. (2+2 points)
6. Using the simple model of Heitler discussed in the class,
   (i) calculate the shower-max depth for 10 GeV and 100 GeV electrons in an electromagnetic calorimeter made with Lead absorbers and scintillators as detectors. (The radiation length $X0 = 180*A/Z^2$ g/cm^2 and critical energy Ec =800 MeV/Z.)
   (ii) Calculate the number of particles at shower-max.
   (iii)Calculate the 95% containment depth for 100 GeV electrons. (iv) Estimate approximately the energy resolution of this calorimeter. (2+1+1+1 points)